CLAIMS

1. Method for damping a torsional oscillation in a rotating drive train having at least one electrical machine (13,72,82), the electrical machine (13,72,82) applying a damping torque to the drive train,
characterized in that
the damping torque is applied at a predetermined damping frequency and antiphase to the angular velocity of the torsional oscillation.

2. Method according to claim 1, **characterized in that** the predetermined damping frequency essentially corresponds to a resonant frequency of the drive train.

3. Method according to claim 1 or 2, **characterized in that** the torsional oscillation of the drive train without the damping torque applied has a quality factor of more than 500.

4. Method according to claim 3, **characterized in that** the quality factor with the damping torque applied lies below 200.

5. Method according to one of the preceding claims, **characterized by** the following steps:
- determination of at least one control variable (33,33'), which represents a torsional loading at at least one site in the drive train, and
- control of the damping torque depending on the control variable (33,33') in a control circuit.

6. Method according to claim 5, **characterized in that** the control variable (33,33') is determined from a measurement signal from one or more sensors (14,14').

7. Method according to claim 6, **characterized in that** the sensors are azimuthally and/or axially spaced from one another in relation to the drive train.

8. Method according to claim 6 or 7, **characterized in that** at least one of the sensors (14,14') is a magnetostrictive sensor and/or a strain gauge and/or a sensor for angular velocity measurement.

9. Method according to at least one of the claims 5 to 8, **characterized in that** a feedback variable is derived from the control variable (33,33'), in that the control variable (33,33') is filtered, phase-shifted and inverted, the overall phase shift in the control circuit substantially amounting to 90°, the feedback variable representing the angular velocity produced by the torsional oscillation at the resonant frequency.

10. Method according to at least one of the preceding claims, **characterized in that** for applying the damping torque, energy is temporarily stored in a direct current circuit with a direct current component and an alternating current component, the temporarily stored energy being taken from an alternating current circuit (31) to which the electrical machine (13,72,82) is connected.

11. Method according to claim 10, **characterized in that** the energy is temporarily stored with at least one coil (41) in the direct current circuit.

12. Method according to claim 10 or 11, **characterized in that** the energy is temporarily stored with at least one capacitor (41') in the direct current circuit.

13. Method according to at least one of the claims 10 to 12, **characterized by** the following steps:
- providing a target value (32,32') for current control or voltage control of the direct current circuit from the direct current component and the alternating current component, the alternating current component representing the feedback variable and having a frequency which substantially corresponds to the resonant frequency, and
- controlling the direct current circuit with the target value via a current converter (42,42') connected to the alternating current circuit (31), effective power being brought about in the electrical machine (13,72,82) via the alternating current circuit (31).

14. Method according to claim 13, **characterized in that** the damping power is adjusted via the size of the direct current component and/or via the size of the alternating current component.

15. Method according to claim 13 or 14, **characterized in that** a maximum of 5% of the power converted by the electrical machine (13,72,82) is used via the current converter (42,42') for damping the torsional oscillation.

16. Method according to at least one of the preceding claims, **characterized in that** the overall mass of the rotating components of the drive train is more than 20 tons.

17. Method according to at least one of the preceding claims, **characterized in that**
the torsional oscillation of at least one further drive train which has at least one further electrical machine is damped, the drive trains having different resonant frequencies.

18. Method according to at least one of the preceding claims, **characterized in that** the electrical machine (13,72,82) is a synchronous machine.

19. Method according to at least one of the claims 10 to 18, **characterized in that** current flows in the direct current circuit only on occurrence of the torsional oscillation in the drive train.

20. Method according to at least one of the preceding claims, **characterized in that** a plurality of torsional oscillations with different frequencies of the rotating drive train are damped, the damping torque containing damping frequency components with predetermined damping frequencies and the damping frequency components being each antiphase to the angular velocity of the corresponding torsional oscillation.

21. Method according to claim 20, **characterized in that** the predetermined damping frequencies substantially correspond to resonant frequencies of the drive train.

22. Method according to claim 20 or 21, **characterized by** the following steps:

- determination of a plurality of control variables (33,33')
- providing a plurality of feedback variables from the control variables (33,33') for the torsional oscillations, each feedback variable having a frequency that is

substantially equal to the frequency of the corresponding torsional oscillations,

- providing the target value (32,32') for current control or voltage control of the direct current circuit from the direct current component and the alternating current component, the alternating current component representing the sum of the feedback variables, and
- controlling the direct current circuit with the target value via the current converter (42,42') connected to the alternating current circuit (31), effective power being brought about in the electrical machine (13,72,82) via the alternating current circuit (31).

23. Damping device for damping a torsional oscillation in a rotating drive train having an electrical machine (13,72,82) and an electrical multipole (31) connected to the electrical machine (13,72,82), where the damping device may be connected via the electrical multipole (31) to the electrical machine (13,72,82) and being arranged for generating a damping torque in the electrical machine (13,72,82),
characterized in that
the damping torque has a predetermined damping frequency and is antiphase to the angular velocity of the torsional oscillation.

24. Damping device according to claim 23, **characterized in that** the predetermined damping frequency substantially corresponds to a resonant frequency of the drive train.

25. Damping device according to claim 23 or 24, **characterized in that** the torsional oscillation of the drive train without the damping torque applied has a quality factor of more than 500.

26. Damping device according to claim 25, **characterized in that** the quality factor with the damping torque applied lies below 200.

27. Damping device according to at least one of the claims 23 to 26, **characterized by**
a controller, which controls the strength of the damping torque depending on a control variable (33,33').

28. Damping device according to claim 27, **characterized by** a measuring equipment and at least one sensor (14,14') for determining the control variable (33,33'), the measuring equipment being linked on the input side to the sensor (14,14').

29. Damping device according to claim 28, **characterized in that** a plurality of sensors are provided, which are azimuthally and/or axially spaced from one another in relation to the drive train.

30. Damping device according to claim 28 or 29, **characterized in that** the at least one sensor (14,14') is a magnetostrictive sensor and/or a strain gauge and/or an angular velocity sensor.

31. Damping device according to at least one of the claims 28 to 30, **characterized in that**
the measuring equipment has a filter (61), which is tuned to the resonant frequency, a phase-shifter (62) and/or an inverter (63) for creating a feedback variable, the feedback variable being an oscillating signal at the damping frequency.

32. Damping device according to at least one of the claims 23 to 31, **characterized by**

an energy storage for intermediate storage of energy, the energy being drawn from the electrical machine (13,72,82) or the multipole (31).

33. Damping device according to claim 32, **characterized in that** the energy storage has at least one coil (41), which is arranged in a direct current circuit with an alternating current component.

34. Damping device according to at least one of the claims 32 to 33, **characterized by**
a current converter (42,42'), via which the energy storage is connectable to the multipole (31) under current control or voltage control.

35. Damping device according to claim 34, **characterized in that** the energy storage has at least one capacitor (41'), which is arranged on the direct current side of the current converter (42,42').

36. Damping device according to at least one of the claims 32 to 35, **characterized in that**
the controller has an adder (65) with two inputs, whose one input is connected to the measuring equipment which outputs the feedback variable and to whose other input a direct current component to be added is applied, the output issuing a target value (32,32') for a control system (50) of the current converter (42,42').

37. Damping device according to claim 36, **characterized in that** the damping power is controllable in that in the controller the amplification factor of the feedback variable and the size of the direct current component are controllable.

38. Damping device according to at least one of the claims 35 to 37, **characterized in that** the current converter (42,42') controls a maximum power level of 5% of the power converted by the electrical machine (13,72,82).

39. Damping device according to at least one of the claims 23 to 38, **characterized in that** the drive train has an overall mass of over 20 tons.

40. Damping device according to at least one of the claims 23 to 39, **characterized in that** one control module and a plurality of power modules are provided, where the power modules can be controlled in parallel by the control module in order to achieve a larger damping power.

41. Damping device according to at least one of the claims 23 to 40, **characterized in that** the electrical machine (13,72,82) is a synchronous machine.

42. Damping device according to at least one of the claims 33 to 41, **characterized in that** the direct current circuit is current-free when no torsional oscillation occurs.

43. Damping device according to at least one of the claims 28 to 42, **characterized by** a plurality of measuring equipments with which feedback variables may be determined for various torsional oscillations of the drive train at different frequencies and which are connected to the one or the plurality of sensors (14,14').

44. Damping device according to claim 43, **characterized in that** the plurality of sensors (14,14') are arranged at sites on the drive train at which the deformations caused by the torsional oscillations are maximal.

45. Damping device according to claim 43 or 44, **characterized by** a feedback variable adder (67), which adds the feedback variables output by the measuring equipments and whose output is linked to the input of the adder (65) of the controller.

46. Use of a damping device according to one of the claims 23 to 45 for damping a torsional oscillation, in particular a resonant torsional oscillation in a drive train of a turbine or wind power generator, a ship drive system (80), a helicopter drive system or a lift drive system or in an upright shaft (70).